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ÇNAEM WASTE PROCESSING AND STORAGE FACILITY

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Abstract

Radioactive waste in Turkey is generated from various applications. Radioactive waste management activities are carried out in a facility at Çekmece Nuclear Research and Training Center (ÇNAEM). This facility has been assigned to take all low-level radioactive wastes generated by nuclear applications in Turkey. The wastes are generated from research and nuclear applications mainly in medicine, biology, agriculture, quality control in metal processing and construction industries. These wastes are classified as low- level radioactive wastes and their activities are up to 10^{-3} Ci/m^3 (except spent sealed sources). Chemical treatment and cementation of liquid radwaste, segregation and compaction of solid wastes and conditioning of spent sources are the main processing activities of this facility. Also, analyses, registration, quality control and interim storage of conditioned low-level wastes are the other related activities of this facility. Conditioned wastes are stored in an interim storage building. All waste management activities, which have been carried out in ÇNAEM, are generally described in this paper.

1. INTRODUCTION

Low-level liquid wastes, solid wastes and spent sealed sources are main inputs of this facility. Maximum capacity for liquid treatment of the facility is 100 m^3 / year. The research reactor is the main source of liquid radwaste. Main source of spent sealed sources is industry. Main sources of solid wastes are hospitals and medical institutes.

2. RADIOACTIVE WASTES

The radioactive wastes, generated by these activities are divided physically into two groups; liquid wastes and solid wastes. Solid waste divided into two groups; non-compactable solid wastes and compactable solid wastes. Non-compactable solid wastes comprise; spent sealed sources, metals, hard parts etc. Compactable solid wastes comprise; gloves, clothes, papers etc. Radioactive waste types and main radionuclides are shown in *Table I.*

Although, processing liquid radwaste volume is about 10 to 70 m^3 in every year, approximately 98% of this processing liquid radwaste have been generated from the research reactor and precipitation has been done in situ conditions. Other liquid radwaste sources generate only 2 % of the total liquid radwaste.

Amount of the received spent sealed sources is about 20 sources per year. Main radionuclides in the spent sealed sources are Cs-137 and Co-60. Their activities vary from a few milicuries to several hundred curies.

TABLE I. RADIOACTIVE WASTE TYPES AND COMMON RADIONUCLIDES

LIQUID RADWASTES	SOLID RADWASTES		
	Compactable Radwaste	Non-compactable Radwaste	
	(contaminated) with	(contaminated) with	Spent Sealed Sources
Natural Uranium	Cs-137	Natural uranium ore	Ra-226
Cs-137	Co-60	Natural thorium ore	Am-241
Co-60		Ni-59	Cs-137
Cs-134		Cs-137	Sr-90
Mn-54		Co-60	Co-60
Ag-110m		Fe-55	Cd-109
Sb-124		Cs-134	Ir-192
(not commonly)	(not commonly)		
Natural Thorium	Natural Uranium		
C-14	Co-57		
Sr-90	Zn-65		
H-3	Se-75		
Zn-65	Ir-192		
Cr-51	I-125		

2.2. Received radioactive wastes

Received amounts of radioactive waste are not regular in the facility. Furthermore, significant amounts of radwaste had been collected before the operation of the facility. Additionally, some chemical precipitation applications have been done in the research reactor tanks and the bottom sludges transported to the facility. These operations caused some irregularities in the amounts of processed waste volumes per year.. During the operational period of this facility, according to the years, amounts of received solid wastes and received liquid wastes are shown respectively in *Figure 1* and *Figure 2*.

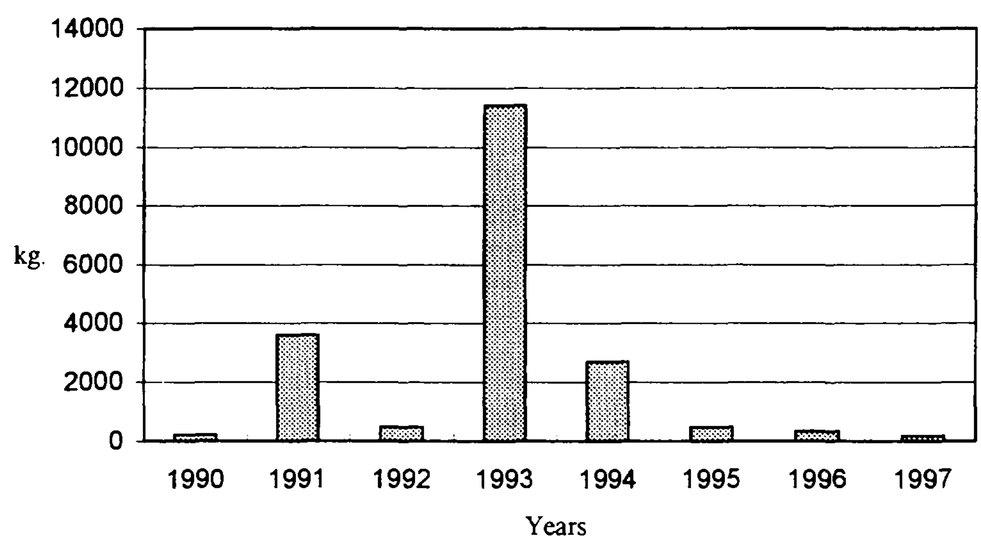

Fig. 1. Received Solid Radioactive Waste [1]

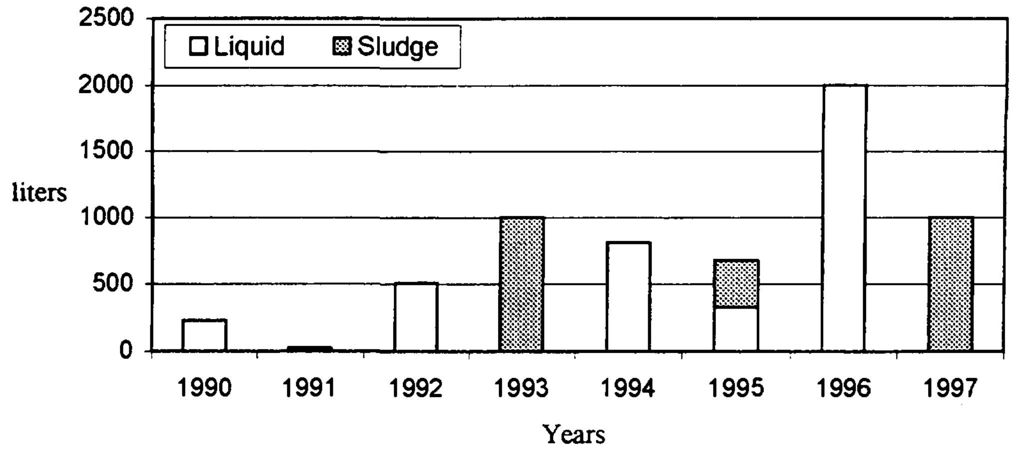

Fig 2. Received Liquid/Sludge Radioactive Wastes [1].

Radioactive waste amount, which are generated only by ÇNAEM; 1 m^3 / year for liquid radioactive waste and 1 m^3 / year for solid radioactive waste (except TR-2 research reactor activities).

3. RADIOACTIVE WASTE PROCESSING FACILITY

3.1. Operational capabilities

These capabilities include; treatment and conditioning of liquid and solid low-level radioactive wastes. For liquid waste management; receiving tank, precipitation tank, pipes, pumps, dosage tanks and an in-drum mixer are existing in the facility as the main equipment. And for compactable solid wastes, a compactor is also available.

3.2. Liquid waste treatment unit

The liquid radwaste facility can treat maximum 1m^3 of liquid radwaste in one batch. Chemical precipitation and cementation processes are used for the treatment of liquid wastes. Treatment of low-level radioactive liquid waste is done by chemical precipitation. After the clear liquid (supernatant) is confirmed as dischargeable, it is discharged after neutralisation. Remain sludge is cemented into 200 liters drums. Liquid radwaste processing unit is shown in *Figure 3*.

3.2.1. Operational procedure

Radioactive liquids come to the facility in various carboys and various amounts (1-40 liters). They have an identification label, which is filled out by producer. These containers are collected nearby the receiving tank. After the receiving of the liquid containers, samples are taken. Usually 1 liter of sample is taken for gamma spectrometric analysis. A manual vacuum apparatus is used to take the sample. The next step is, analysing of the liquid waste; it has a significant operation to decide the convenient treatment procedure. According to the registration of the received liquid waste, following analyses are applied on the sample; gamma radioactivity analyses, total alpha and beta counting, dose rate measurement, pH measurement and conductivity measurement. After transferring the liquid to the collection tank (T1) by an automatic pump, mixing the collected liquids in receiving tank for desired duration is carried out. After the mixing, 1 m^3 of liquid is transferred from receiving tank (T1) to the precipitation tank (T2). T2 tank liquid is analysed to gain the information about the exact activity concentrations of nuclides in liquid. Calculation of the sludge/cement ratio to be applied in the facility is found out with simulated experiments in the laboratory. Besides of these operations, chemicals and their required concentrations are determined by several related experiments. Jar tests applied on this sample to determine the convenient concentrations and pH degree for optimum precipitation. Then dosage solutions are prepared. Three dosage tanks are located over the platform. Each one has a manual mixing possibility and a dosage pump [2].

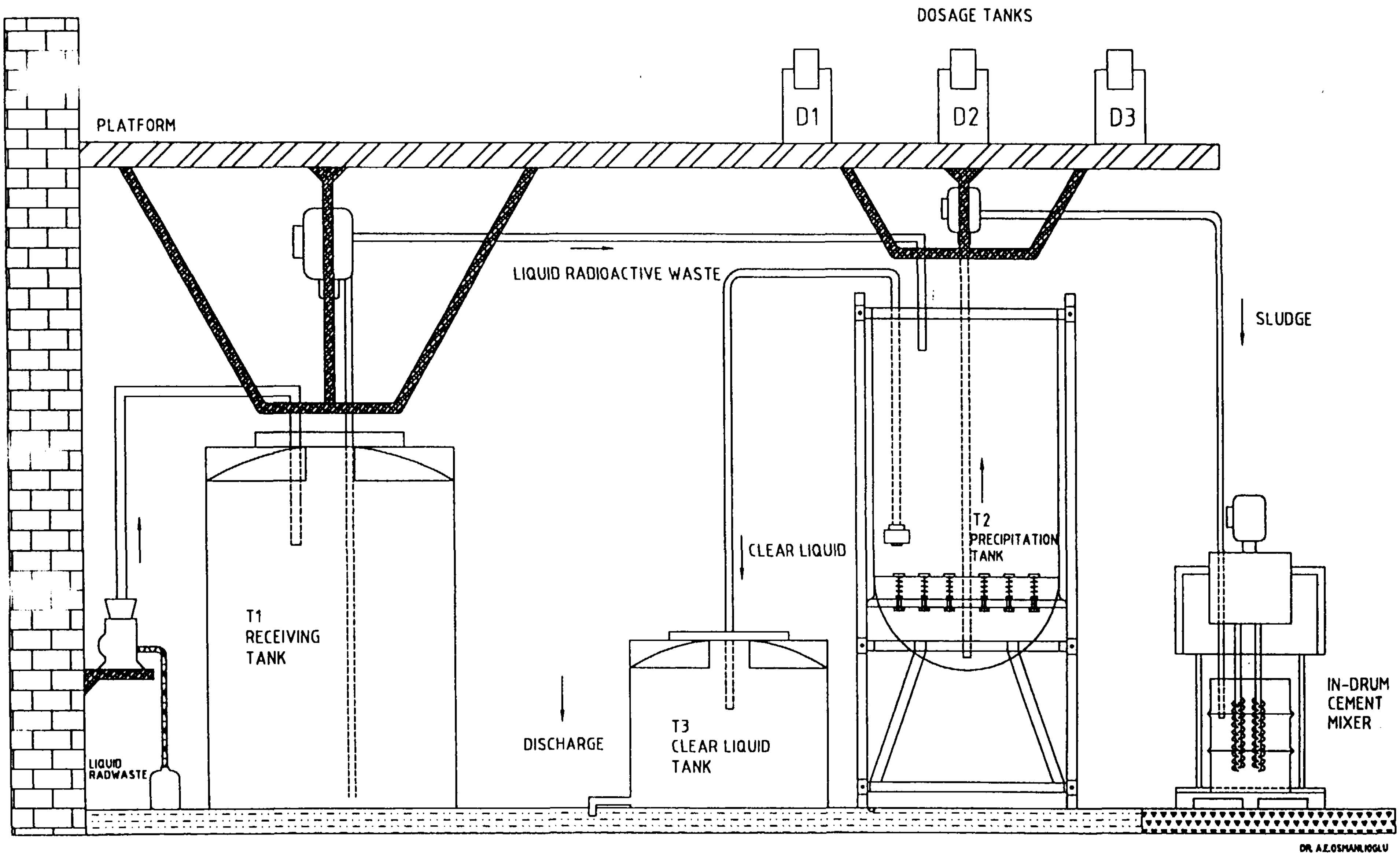

FIG. 3. Liquid radioactive waste treatment unit (Çnaem).

- D1 Acid (usually nitric acid)
- D2 Alkaline (usually sodium hydroxide)
- D3 Precipitator (usually an iron salt solution)

After the addition of dosage solutions in T2 tank, jet mixer with recycle mixing is used for mixing. Flocks begin to settle down when the mixing is stopped. It takes about 1 to 3 hours. Later on, the supernatant is transferred from precipitation tank to clear liquid tank (T3). For the calculation of decontamination factors and radioactivity analyses, samples are taken from T3 tank. If the supernatant is dischargeable (it means, under the exemption level), after adjusting the pH degree it is discharged. If not, secondary precipitation procedure is applied on it.

Then the sludge is transferred from T2 tank to cementation unit. In-drum cement mixer and standard 200 liters cylindrical drums (d: 60 cm, h: 88 cm) are used for the immobilisation of the sludge by cementation.

Sampling of the sludge - cement composite, radioactivity measurement, optimum hardening time, quality control tests, fill the upper 2-3 cm with clean cement composite, surface contamination checks and registration are the last steps of conditioning. After waiting 10 days for curing, drum is covered with its lid and tightened.

3.3. Compaction of solid wastes

Solid wastes are received in plastic or nylon bags. These bags contain an information label on them. Surface dose rate and weight are measured and a registration card is filled out. If necessary, additional analyse can be carried out. The bags are grouped according to the data on the registry. Solid wastes are segregated as compactable and non-compactable wastes in the facility. Second segregation is performed according to the radionuclide type as the contaminant.

400 kN hydraulic compactor with 530-mm piston diameter is used for compaction. The usual types of solid wastes are plastic tubes, papers, gloves, clothes, PVC materials, laboratory glassware, emptied containers and some secondary wastes generated during the treatment of liquids. Their origins are; research laboratories, radioisotope production department, nuclear fuel pilot plant activities, radiobiology department, and TR-2 research reactor activities.

3.4. Conditioning of spent sealed sources

As soon as the source container or equipment is received, surface dose rate is measured and an identification number is given. The nuclide type can be found out by using the gamma spectrometer. The ÇNAEM has been receiving about 20 sources per year from industry and hospitals.

3.4.1. Operational procedure

Initially, about 10 cm of concrete filled into the drum to prevent the contact of sealed source to the bottom of the drum. And three or more reinforcement bars are placed in it. After the hardening of the bottom concrete (3 to 10 days), the source is placed at the centre of the drum. Then the drum is filled completely with concrete. Surface dose rate calculations have been done before the operation; if additional shielding is necessary then lead sheets may be placed around the original shield of source. Amount of ingredients of the concrete is determined according to the quality control experiments.

4. CONDITIONED RADIOACTIVE WASTES

Total amount of conditioned (liquid radwaste and spent sealed sources) radwaste drums are about 10 to 20 drums per year. Only 20 % of total conditioned radwaste drums are including spent sealed sources.

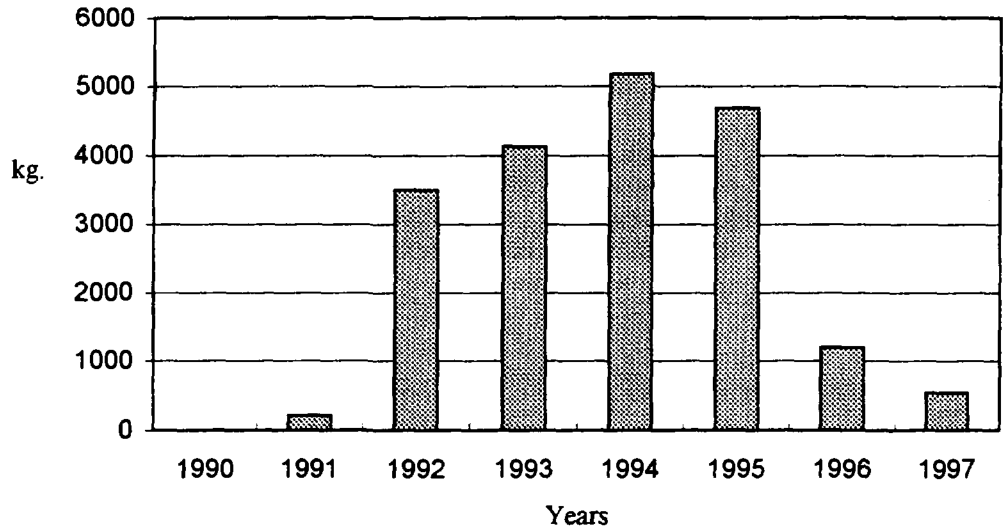

Fig 4. Conditioned Solid Radioactive Waste

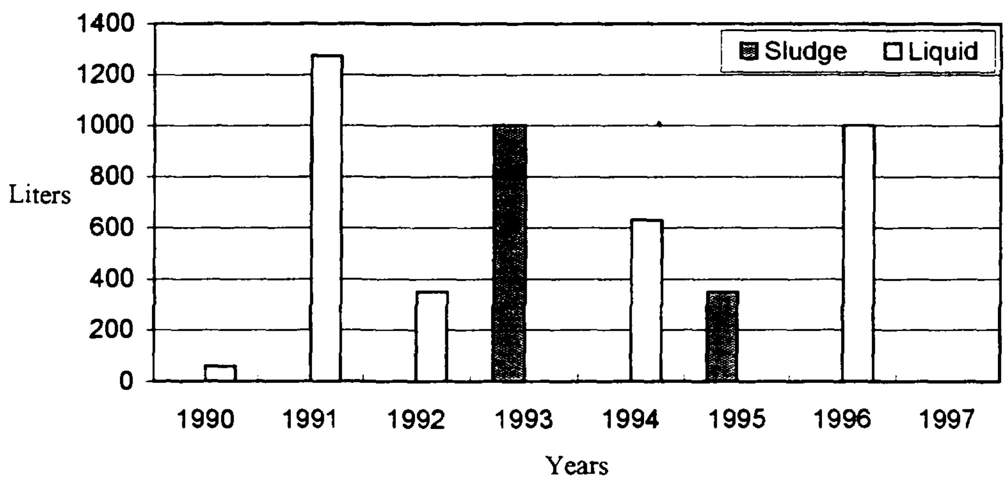

Fig 5. Conditioned Liquid / Sludge Radioactive Waste

5. QUALITY CONTROL TESTS

Quality of cemented radwaste forms influenced by these factors; cement type, water properties, cement / water ratio, aggregate or sand type, particle size distribution of sand or aggregate, mixing mechanism, additives, curing time, temperature, humidity etc.

The solidified (cemented) liquid radioactive wastes are characterised by strong resistance to leach aimed as low release rates of radionuclides to the environment. Leach tests are applied on the conditioned radwaste samples to measure the leaching rate of nuclides from the cemented radioactive wastes. Static type long-term leaching test is applied to measure this resistance to leach of cemented wastes.

Compressive strength of cemented waste is important for the long-term stability of conditioned wastes. Cubic split moulds of cast iron or mild steel is used. Samples of cemented radwastes to be tested are cast in the form of cubes (10 cm per side). Manual controlled hydraulic compression machine is used to determine the ultimate strength value of these samples in MPa.

6. INTERIM STORAGE OF CONDITIONED WASTE

After the preparation of registration cards and codes of conditioned waste drums, they are transported to interim storage building. Waste management activities in Turkey have not comprised disposal stage yet. Interim storage building exists as the last stage for conditioned waste drums. Interim storage period provides;

- Sufficient observation time under institutional control
- Discharging of the short-lived radionuclides
- Sufficient time for investigation on site selection, construction and disposal.

Storage building is located approximately 150 meters away from the ÇNAEM. (15m x 8m =120 m^2, and height is 3 meters). Existing capacity of the building is about 600 drums for standard 200 lt. drums.

REFERENCES

[1] TURKISH ATOMIC ENERGY AUTHORITY, Progress Reports, Çekmece Nuclear Research and Training Center, Istanbul, Turkey (1990 -1997).

[2] FRIEDRICH, V.; KAHRAMAN, A.; OSMANLIOGLU, A.E.; "Demonstration of Predisposal Radioactive Waste Management Methods and Procedures", IAEA, Vienna, Austria (1996).